WISCONSIN DEPT. OF NATURAL RESOURCES

Determining Residual Contaminant Levels Using the EPA Soil Screening Level Web Site

Environment Remediation and Redevelopment Program Partnership Cleanup Redevelopment

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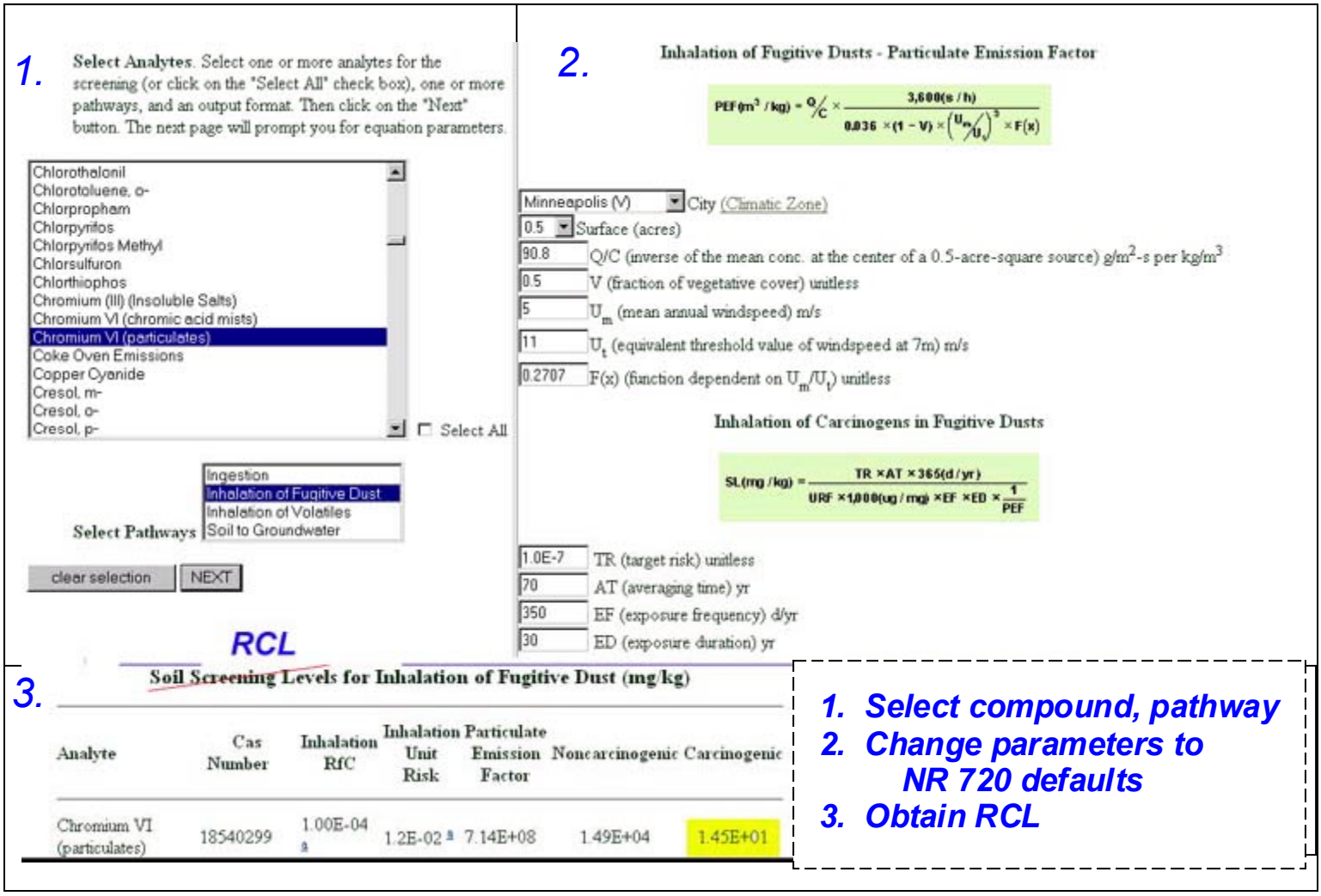
http://risk.lsd.ornl.gov/epa/ssl1.htm



PURPOSE

This guidance is intended for Department of Natural Resources staff and for the public, for use in understanding and applying the administrative rules that are applicable to the cleanup of soil contamination (NR 720, Wis. Adm. Code). This guidance does not contain mandatory requirements except where requirements found in statute or administrative rule are referenced.

Disclaimer: *This document is intended solely as guidance and does not contain any mandatory requirements except where requirements found in statute or administrative rule are referenced. This guidance does not establish or affect legal rights or obligations and is not finally determinative of any of the issues addressed. This guidance does not create any rights enforceable by any part in litigation with the State of Wisconsin or the Department of Natural Resources. Any regulatory decisions made by the Department of Natural Resources in any matter addressed by this guidance will be made by applying the governing statutes and administrative rules to the relevant facts.*

GUIDANCE REVISIONS

This guidance will be updated as needed. Comments and concerns may be sent to "Guidance Revisions", Ed Lynch - RR/3, WDNR, P.O. Box 7921, Madison, WI 53707, phone number (608) 266-3084, internet e-mail *lynche@dnr.state.wi.us*.

DETERMINING RESIDUAL CONTAMINANT LEVELS USING THE EPA SOIL SCREENING LEVEL WEB SITE

Summary

One very useful web resource to determine soil residual contaminant levels (RCLs) is accessible at *http://risk.lsd.ornl.gov/epa/ssl1.htm*. This EPA Risk Assessment Guidance web site allows users to carry out the algorithms to determine soil screening levels (EPA, 1996). One can use the web site to calculate RCLs that will be in accord with NR 720, Wis. Adm. Code. However, to do so, some of the default parameters in the web site need to be replaced. This document describes what values to use to calculate generic Wisconsin RCLs. With enough familiarity, users can plug important site-specific factors, such as fraction of organic carbon and hydraulic conductivity, into the web site calculation to determine site-specific RCLs.

The Web Site: *http://risk.lsd.ornl.gov/epa/ssl1.htm*

Brief Description. The web site gives the options of: (1) selecting one specific compound or a number of compounds (*via* "Ctrl-clicking") that may be of concern at a site and selecting one or all four different exposure pathways that could affect human health, (2) changing the exposure and soil parameters, and then (3) calculating the soil screening levels (SSL). Since the web site is linked to current toxicological data (such as reference concentration, reference dose, unit risk factor and oral slope factor), and chemical/physical properties (such as solubility, Henry's Law constant and diffusivity values) for various compounds, the web-calculated SSL is more up-to-date than the generic SSLs that are listed in the US EPA (1996) guidance document (available at: *http://www.epa.gov/superfund/resources/soil/introtbd.htm*). With the option to adjust the exposure and soil parameters, the web site can be used as a tool to determine residual contaminant levels (RCLs) that are in accord with NR 720.

Purpose/Goal of Guidance. This guidance aims to help users determine generic RCLs. Ch. NR 720, Wis. Adm. Code, put constraints on the target hazard quotient (THQ ≤1), hazard index (Σ THQ = HI ≤ 1), target cancer risk (TCR ≤ 10^{-6}), cumulative risk (Σ TCR = CR ≤ 10^{-5}), and target groundwater concentration (≤ NR 140 PAL) when determining RCLs. To determine generic residential RCLs, we use a THQ and TCR of 0.2 and 10^{-7}, respectively, and an array of other exposure assumptions. The figures in this guidance can be used to look up which parameters in the web pages to change, and what to replace them with, to determine generic direct-contact RCLs (Figures 1 thru 3) and generic groundwater-pathway RCLs (Figure 4). As users become familiar with the EPA web site, they will be able to use it in developing site-specific RCLs.

Limitation in Applying the Results from the Web Site. Users should bear in mind the limitations of generic RCLs. The first and foremost limitation is the area of the site. The generic RCLs implicitly assume a contaminated area of no more than half (0.5) acre. The limitation of site area can be illustrated by considering the generic RCL of 14-ppm hexavalent chromium at a 0.5-acre residential site. If the 14-ppm concentration is the only consideration, then at a 10-acre site, highly contaminated soil can be diluted by spreading it over a larger area. Diluting the contamination is not only an inappropriate remedy, but the redistribution could prove more detrimental to human health than containing the contaminants in a smaller area.

The generic RCLs are useful in assessment-type decisions. For instance, if during an investigation, the soil analytical data show exceedance of the groundwater-pathway RCL, a project manager may decide to install monitoring wells to determine if the pathway has been completed. But the timing of well installation, or other response action, is a decision independent of the generic RCLs. In the matter of whether to treat excavated soil as hazardous waste, the RR Program plans to issue further guidance on making hazardous waste determinations at remediation sites in the near future.

Generic RCLs can be used in much the same way as NR 140 Preventive Action Limits (PALs) are used to compare groundwater data collected at a contaminated site. To be able to do so, the soil analyses should be compound-specific. This means that specific analyses for benzene or individual PAHs (rather than GRO or DRO) are essential. The comparison of site data to the estimated generic RCLs are straightforward if the following are *all* true:

- Site has an area of 0.5 acres or less. Otherwise, the generic levels may need to be scaled downward.
- The contaminant is not a mixture of compounds. If several contaminants are involved, additional appropriate factors may be necessary, so that both the hazard quotient and cancer risk constraints in NR 720 are met. For instance, when a contaminant's RCL is at its soil saturation concentration, then no other contaminant (at whatever level) can be present; otherwise, the physical soil capacity to hold the contaminant is exceeded. If several contaminants are present, their individual soil-saturation-concentration RCLs must be scaled downward to make sure that the soil can still adequately "hold" them.
- Site does not pose any ecological risk. The web site is specific to human health risk, and does not consider ecological risk.
- Site does not pose any safety risk. For instance, methane can be at an explosive level, but still significantly below the inhalation level where it would be an asphyxiant.
- Indoor-air pathway is not a consideration. A study in Massachusetts suggested that the soil screening levels for chlorinated volatile organic compounds (CVOCs) may not be conservative enough, such that adverse effects on indoor air quality may be anticipated if CVOC levels are found at their screening levels (Fitzpatrick and Fitzgerald, Massachusetts Department of Environmental Protection, An evaluation of vapor intrusion into buildings through a study of field data, 17 pp., Presented at the *11th Annual Conference on Contaminated Soils*, University of Massachusetts at Amherst, October 1996).
- Site does not pose a dermal-contact risk. The web site does not include this pathway. There are very few compounds where the risk from dermal contact is greater than the risk

from ingestion (*e.g.*, pentachlorophenol, benzo(a)pyrene). For the dermal contact RCL for these compounds, a fraction (*i.e.*, 50%) of the ingestion RCL may be used.

- The NR 140 ES (enforcement standard) is the same as the federal drinking water MCL (maximum contaminant level). Compounds may have ESs that are not the same as the federal MCL/G (MCL goal) or HBL (health-based limit). For instance, naphthalene's HBL (730 ug/l), which is used in the web site, is much higher than its ES (40 ug/l), so the calculated level in soil from the web site for naphthalene must be scaled downward to get the generic groundwater-pathway RCL that is applicable in Wisconsin.

Determining WI Default Values for Exposure Pathways

Figures 1 to 4. Figures 1 thru 4 show the Wisconsin default parameters for 4 exposure pathways for the 2 land uses (non-industrial and industrial) in NR 720. For sites which meet the limitations or assumptions outlined in the previous section, the parameters in the figures can be "plugged" into the appropriate boxes in the web pages to determine generic RCLs for ingestion (fig. 1), inhalation of fugitive dusts (fig. 2), inhalation of volatiles (fig. 3), and soil-to-groundwater (fig. 4) pathways.

Example Calculations

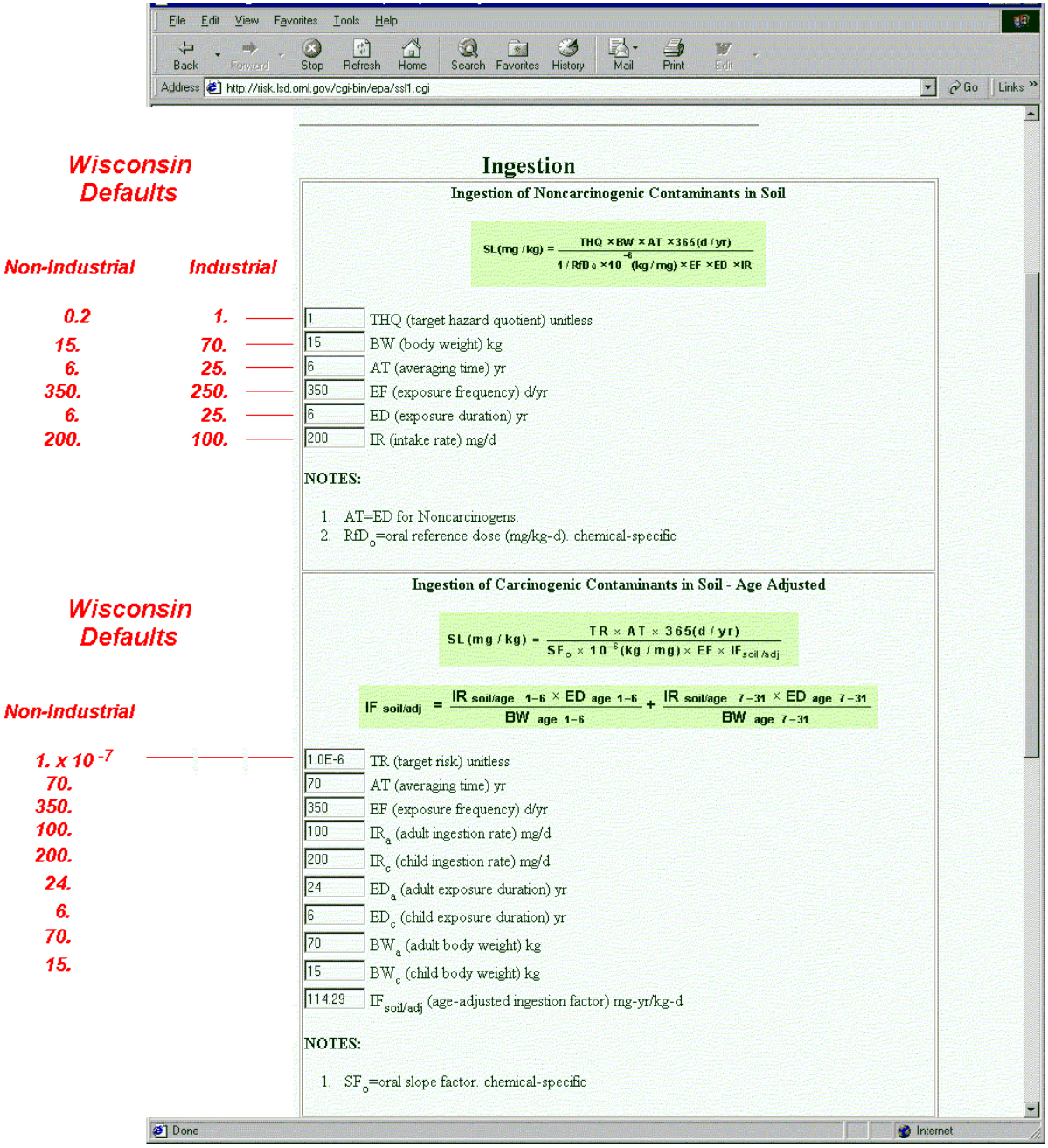
Example Results. The Appendix has the results for the generic RCLs of several CVOCs. The soil-to-groundwater pathway may not be as straightforward as the direct pathways. To show how to compensate for the web site's use of federal drinking water standard (when it varies from the NR 140 ES standard), we provide a couple of examples for this pathway. In Appendix figures C and D, we show how to adjust for the difference by changing the dilution factor (DAF). Care should be taken when determining RCLs for several chemicals all at once because the DAF can be chemical-specific. Users are encouraged to corroborate the results in the Appendix when they visit the web site.

Note about the footnotes. The footnotes in this guidance are important to understand the finer points in using the web site to determine RCLs. Users should read them to properly use the web site.

For more information, or if you have additional questions, contact Resty Pelayo at (608) 267-3539.

Figure 1

Default Parameters[1] to Use in Calculating Generic Soil **Ingestion** RCL



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[1] *"Wisconsin Defaults" are the parameters to use to determine generic RCLs that are in accord with NR 720, Wis. Adm. Code.*

Ingestion, continued

Industrial

Ingestion of Carcinogenic Contaminants in Soil - Nonadjusted

$$SL(mg/kg) = \frac{TR \times BW \times AT \times 365(d/yr)}{SF_o \times 10^{-6}(kg/mg) \times EF \times ED \times IR}$$

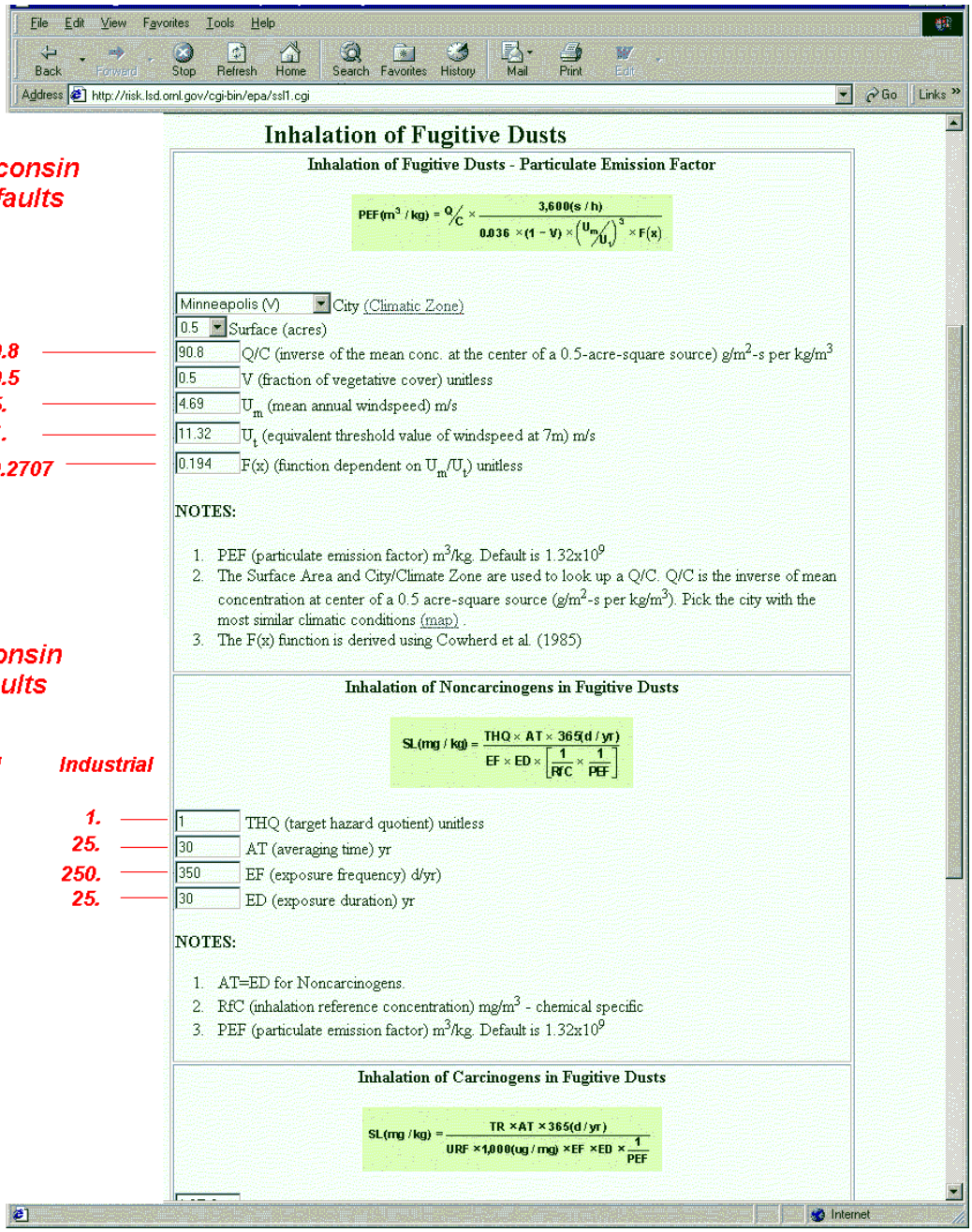
1. x 10 -6 1.0E-6	TR (target risk) unitless
70. 70	BW (body weight) kg
70. 70	AT (averaging time) yr
250. 250	EF (exposure frequency) d/yr
25. 25	ED (exposure duration) yr
100. 50	IR (intake rate) mg/d

NOTES:

1. SF_o=oral slope factor. chemical-specific
2. **Use this pathway for adult-only situations (i.e. worker, etc.)**

Figure 2

Default Parameters to Use in Calculating Generic **Particulate**[2] **Inhalation** RCL



These values (when plugged in the PEF equation) will give:

1/PEF = 1.4 µg/m^3
= 1.4 x 10^{-9} kg/m^3

90.8
0.5
5.
11.
0.2707

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[2] *The particulate emission factor (PEF) is defined in NR 720.19(5)(c) in terms of a concentration of 1.4 µg/m^3 of contaminated soil particles with diameter of less than 10 µm.*

Fugitive dust, continued

Non-Industrial	Industrial	
0.2	1.	THQ (target hazard quotient) unitless
30.	25.	AT (averaging time) yr
350.	250.	EF (exposure frequency) d/yr)
30.	25.	ED (exposure duration) yr

NOTES:

1. AT=ED for Noncarcinogens.
2. RfC (inhalation reference concentration) mg/m^3 - chemical specific
3. PEF (particulate emission factor) m^3/kg. Default is $1.32x10^9$

Wisconsin Defaults

Non-Industrial	Industrial	
1. x 10 -7	1. x 10 -6	TR (target risk) unitless
70.	70.	AT (averaging time) yr
350.	250.	EF (exposure frequency) d/yr
30.	25.	ED (exposure duration) yr

NOTES:

1. URF (inhalation unit risk factor) $(ug/m^3)^{-1}$ - chemical specific
2. PEF (particulate emission factor) m^3/kg. Default is $1.32x10^9$

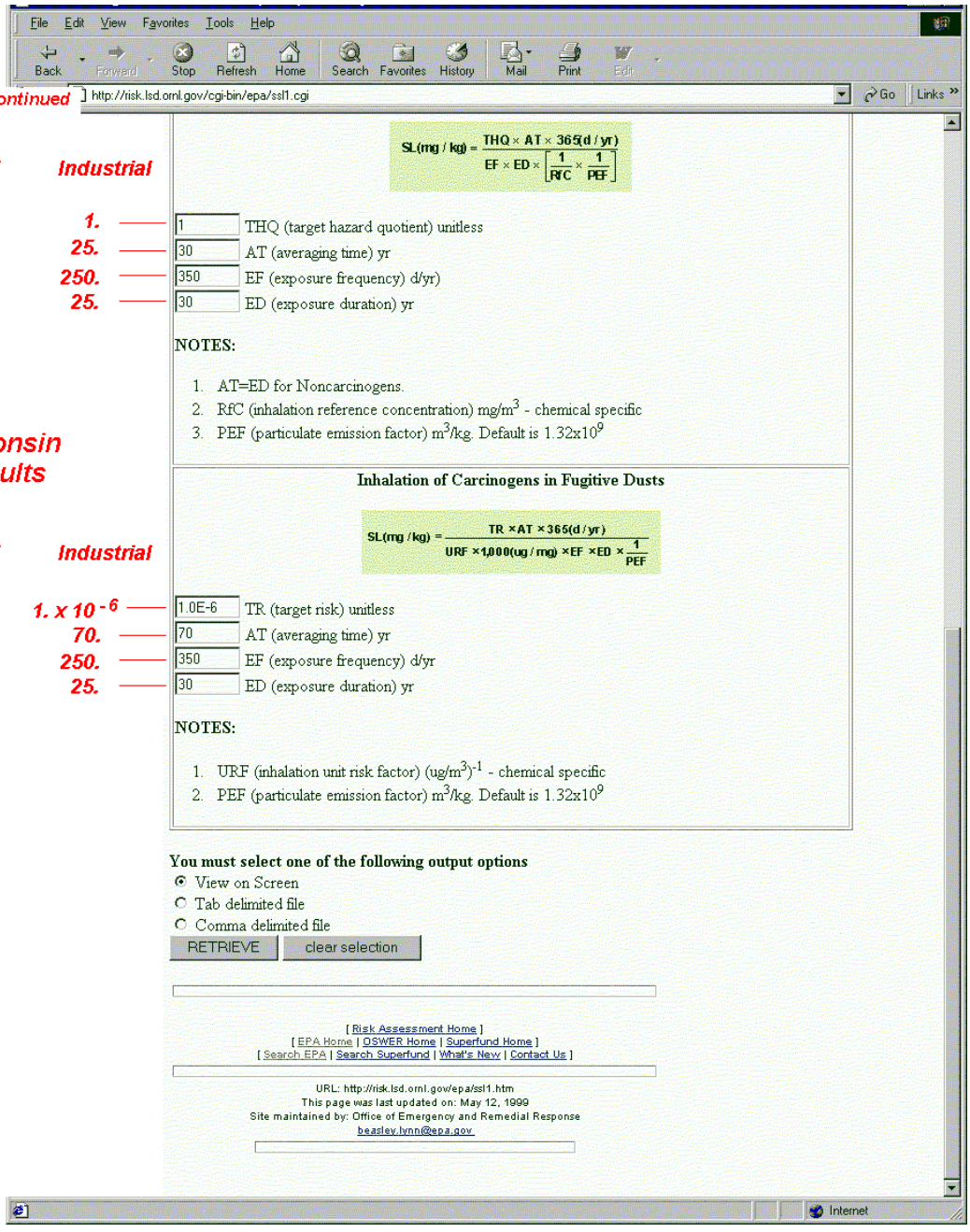
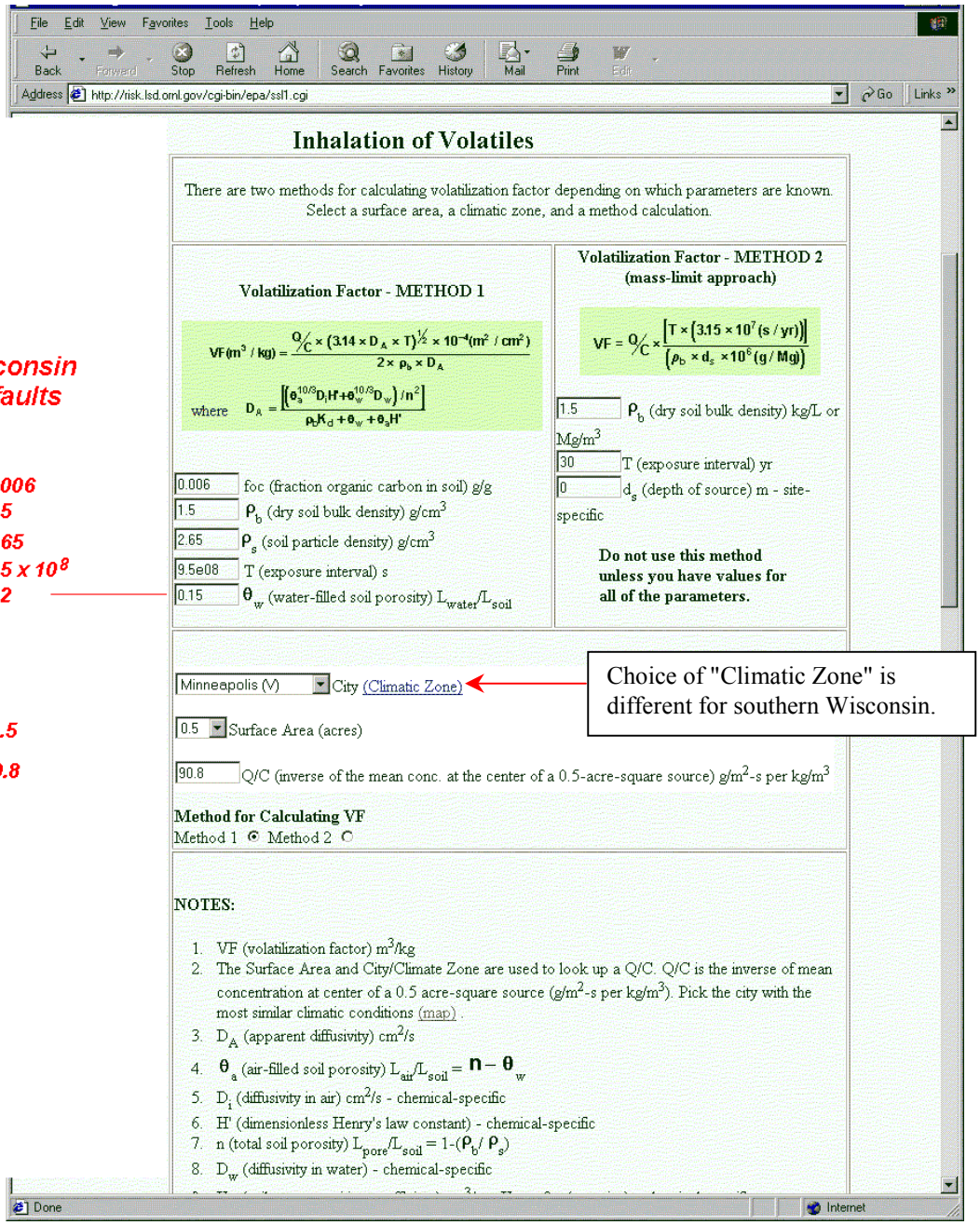


Figure 3

Default Parameters to Use in Calculating Generic **Volatile Inhalation**[3] RCL



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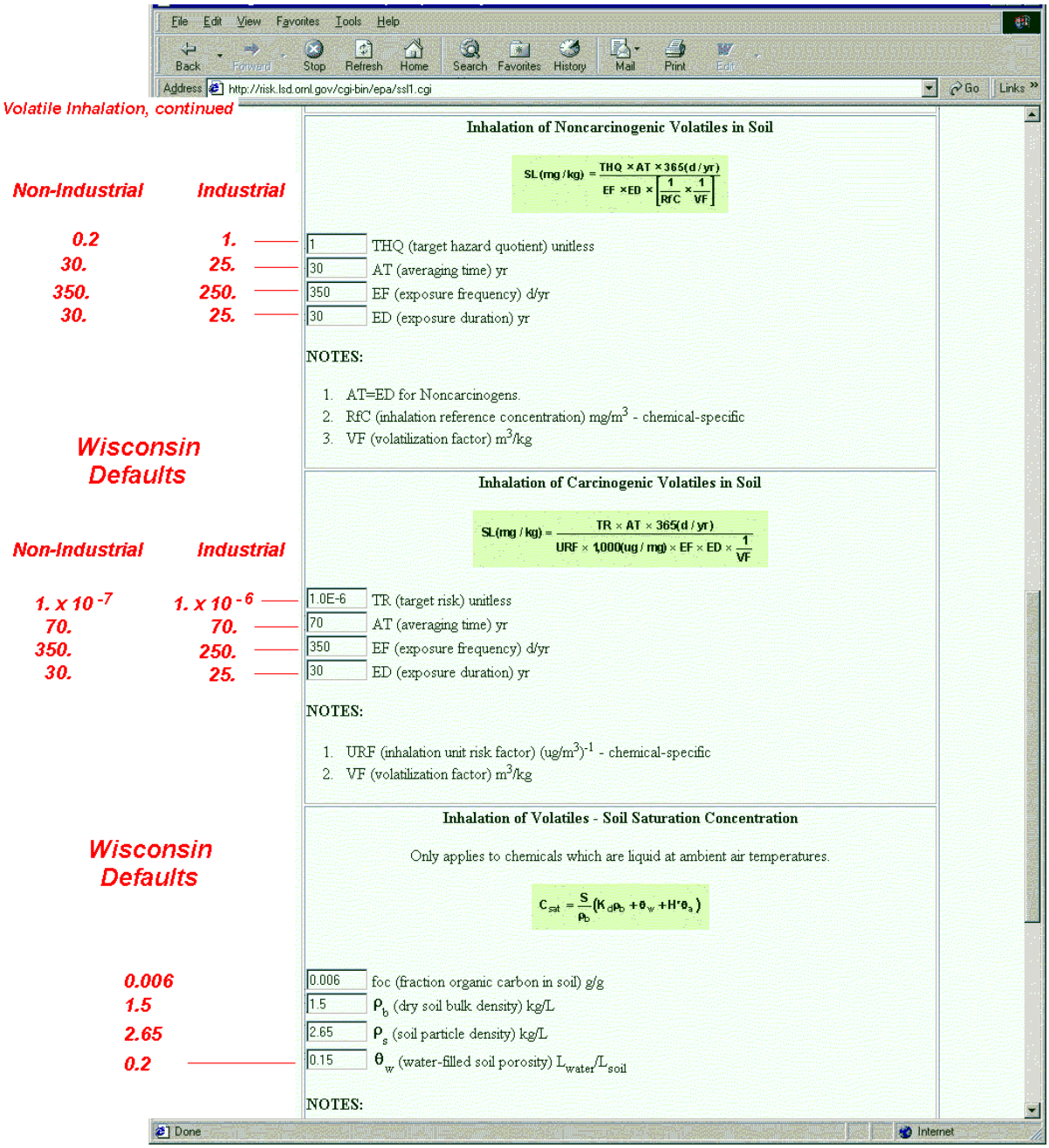
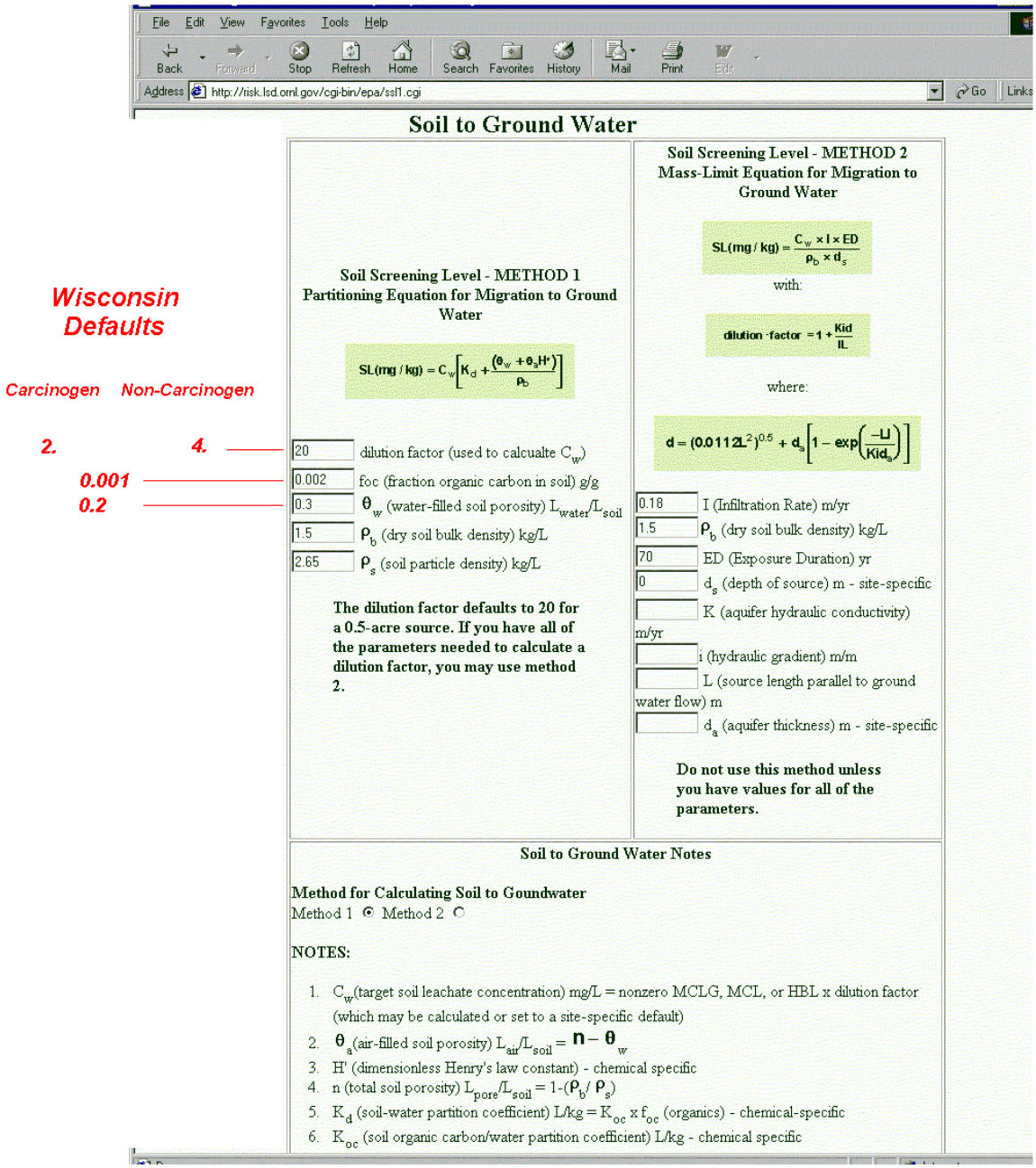
[3] *For the volatile inhalation RCL, the soil saturation concentration (if less) must be used, and not the volatization-factor-derived result. If the contaminant is a mixture of compounds, the soil saturation concentration for each compound may need to be multiplied by the mole fraction of the compound in the mixture, so that a non-aqueous phase liquid (NAPL) would not be present.*



* *See footnote 3.*

Figure 4

Default Parameters to Use in Calculating Generic **Soil to Groundwater**[4] RCL



[4] *The appropriate target soil leachate concentration (the term C_W in the above equation) must be equal to NR 140 PAL x 20 (i.e., 2 x carcinogen ES, or 4 x non-carcinogen ES).* ***The dilution factors above are appropriate only if the federal MCL used in the web site is the same as NR 140 ES.*** *If not, say a federal MCL does not exist, the above factors may not be appropriate. See Appendix for examples of how to derive PAL-based RCLs from the resulting SSLs. Note that if non-aqueous phase liquids (NAPLs) are present, the partitioning equation above is NOT applicable because the resulting concentration from the equation may be higher than the saturation limit.*

Appendix

Results[5] from http://risk.lsd.ornl.gov/epa/ssl1.htm for Some Chlorinated VOCs

A. Direct contact RCL - Non-Industrial site

EPA United States Environmental Protection Agency — Superfund Risk Assessment

Equation Values for Ingestion

Noncarcinogenic Parameter	Value	Carcinogenic Age-adjusted Parameter	Value	Carcinogenic Nonadjusted Parameter	Value
Target Hazard Quotient (unitless)	0.2	Target Risk (unitless)	1.0E-7	Target Risk (unitless)	1.0E-6
Body Weight (kg)	15	Adult Body Weight (kg)	70	Body Weight (kg)	70
		Child Body Weight (kg)	15		
Exposure Duration (yr)	6	Adult Exposure Duration (yr)	24	Exposure Duration (yr)	25
		Child Exposure Duration (yr)	6		
Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	250
Intake Rate (mg/day)	200	Adult Intake Rate (mg/day)	100	Intake Rate (mg/day)	100
		Child Intake Rate (mg/day)	200		
		Average Lifetime (yr)	70	Average Lifetime (yr)	70
		Age-adjusted Ingestion Factor (mg-yr/kg-day)	114.29		

Soil Screening Levels for Ingestion (mg/kg)

Only use results in this column for industrial sites.

Analyte	Cas Number	Oral RfD	Oral Slope Factor	Noncarcinogenic	Carcinogenic (Age-adjusted)	Carcinogenic (Nonadjusted)
Dichloroethylene, 1,2-cis-	156592	1.00E-02 b		1.56E+02		
Dichloroethylene, 1,2-trans-	156605	2.00E-02 a		3.13E+02		
Tetrachloroethylene	127184	1.00E-02 a	5.20E-02 v	1.56E+02	1.23E+00	5.50E+01
Trichloroethylene	79016	6.00E-03 v	1.10E-02 v	9.39E+01	5.81E+00	2.60E+02
Vinyl Chloride	75014	3.00E-03	1.40E+00 b	4.69E+01	4.56E-02	2.04E+00

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[5] *The highlighted concentrations indicate the appropriate generic RCLs related to land use. For direct-contact, the generic RCL is the least level from among the direct pathways (note that groundwater is considered an "indirect" pathway) and (carcinogen/non-carcinogen) endpoints from the resulting SSLs. Note that if non-aqueous phase liquids (NAPLs) are present, the partitioning equation above is NOT applicable because the resulting concentration from the equation may be higher than the saturation limit.*

Equation Values for Inhalation of Volatiles

Volatilization Factor Parameter	Value	Soil Saturation Concentration Parameter	Value	Noncarcinogenic Parameter	Value	Carcinogenic Parameter	Value
Surface Area (acres)	0.5			Target Hazard Quotient (unitless)	0.2	Target Risk (unitless)	1.0E-7
City (climate zone)	Minneapolis (V)			Exposure Duration (yr)	30	Exposure Duration (yr)	30
Q/C (g/m^2-s per kg/m^3)	90.8			Exposure Frequency (day/yr)	350	Exposure Frequency (day/yr)	350
Fraction organic carbon (unitless)	0.006	Fraction organic carbon (unitless)	0.006			Average Lifetime (yr)	70
Dry soil bulk density (g/cm^3)	1.5	Dry soil bulk density (g/cm^3)	1.5				
Soil particle density (g/cm^3)	2.65	Soil particle density (g/cm^3)	2.65				
Water-filled soil porosity (L_{water}/L_{soil})	0.2	Water-filled soil porosity (L_{water}/L_{soil})	0.2				
Exposure interval (s)	9.5e08						

Soil Screening Levels for Inhalation of Volatiles (mg/kg)

Analyte	Cas Number	Inhalation RfC	Inhalation Unit Risk	Volatilization Factor	Soil Saturation Concentration	Noncarcinogenic	Carcinogenic
Dichloroethylene, 1,2-cis-	156592			5.4E+03	1.3E+03		
Dichloroethylene, 1,2-trans-	156605			4.3E+03	3.2E+03		
Tetrachloroethylene	127184	6.0E-01 [v]	5.8E-07 [v]	4.6E+03	2.4E+02	5.8E+02	1.9E+00
Trichloroethylene	79016		1.7E-06 [v]	5.9E+03	1.3E+03		8.5E-01
Vinyl Chloride	75014	1.0E-01	8.8E-06 [b]	1.9E+03	1.2E+03	3.9E+01	5.2E-02

B. Direct contact RCL - Industrial Site

Equation Values for Inhalation of Volatiles

Volatilization Factor Parameter	Value	Soil Saturation Concentration Parameter	Value	Noncarcinogenic Parameter	Value	Carcinogenic Parameter	Value
Surface Area (acres)	0.5			Target Hazard Quotient (unitless)	1	Target Risk (unitless)	1.0E-6
City (climate zone)	Minneapolis (V)			Exposure Duration (yr)	25	Exposure Duration (yr)	25
Q/C (g/m^2-s per kg/m^3)	90.8			Exposure Frequency (day/yr)	250	Exposure Frequency (day/yr)	250
Fraction organic carbon (unitless)	0.006	Fraction organic carbon (unitless)	0.006			Average Lifetime (yr)	70
Dry soil bulk density (g/cm^3)	1.5	Dry soil bulk density (g/cm^3)	1.5				
Soil particle density (g/cm^3)	2.65	Soil particle density (g/cm^3)	2.65				
Water-filled soil porosity (L_{water}/L_{soil})	0.2	Water-filled soil porosity (L_{water}/L_{soil})	0.2				
Exposure interval (s)	9.5e08						

Soil Screening Levels for Inhalation of Volatiles (mg/kg)

Analyte	Cas Number	Inhalation RfC	Inhalation Unit Risk	Volatilization Factor	Soil Saturation Concentration	Noncarcinogenic	Carcinogenic
Dichloroethylene, 1,2-cis-	156592			5.4E+03	1.3E+03		
Dichloroethylene, 1,2-trans-	156605			4.3E+03	3.2E+03		
Tetrachloroethylene	127184	6.0E-01 [v]	5.8E-07 [v]	4.6E+03	2.4E+02	4.0E+03	3.3E+01
Trichloroethylene	79016		1.7E-06 [v]	5.9E+03	1.3E+03		1.4E+01
Vinyl Chloride	75014	1.0E-01	8.8E-06 [b]	1.9E+03	1.2E+03	2.7E+02	8.7E-01

(RCLs for ingestion and particulate inhalation are NOT included because they are larger than the highlighted levels.)

C. Groundwater-Pathway RCL (Based on soil-moisture with concentration of 20 x PAL)

1. For carcinogens (with ES = MCLG or MCL)

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Equation Values for Soil to Ground Water

Partitioning Equation Parameter	Value
Dilution factor (unitless)	2
Fraction organic carbon in soil (unitless)	0.001
Water-filled soil porosity (L_{water}/L_{soil})	0.2
Dry soil bulk density (kg/L)	1.5
Soil particle density (kg/L)	2.65

Soil Screening Levels for Soil to Ground Water (mg/kg)

Analyte	Cas Number	Ground Water Concentration* (mg/L)	Ground Water Concentration Source	Soil Screening Level
Dichloroethylene, 1,2-cis-	156592	1.4E-01	MCLG	2.7E-02
Tetrachloroethylene	127184	1.0E-02	MCL	4.1E-03
Trichloroethylene	79016	1.0E-02	MCL	3.7E-03

2. For trans 1,2-dichloroethylene (consider as a non-carcinogen with ES = MCLG)

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Equation Values for Soil to Ground Water

Partitioning Equation Parameter	Value
Dilution factor (unitless)	4
Fraction organic carbon in soil (unitless)	0.001
Water-filled soil porosity (L_{water}/L_{soil})	0.2
Dry soil bulk density (kg/L)	1.5
Soil particle density (kg/L)	2.65

Soil Screening Levels for Soil to Ground Water (mg/kg)

Analyte	Cas Number	Ground Water Concentration* (mg/L)	Ground Water Concentration Source	Soil Screening Level
Dichloroethylene, 1,2-trans-	156605	4.0E-01	MCLG	9.8E-02

*Ground Water Concentration=Ground Water Concentration Source × Dilution Factor

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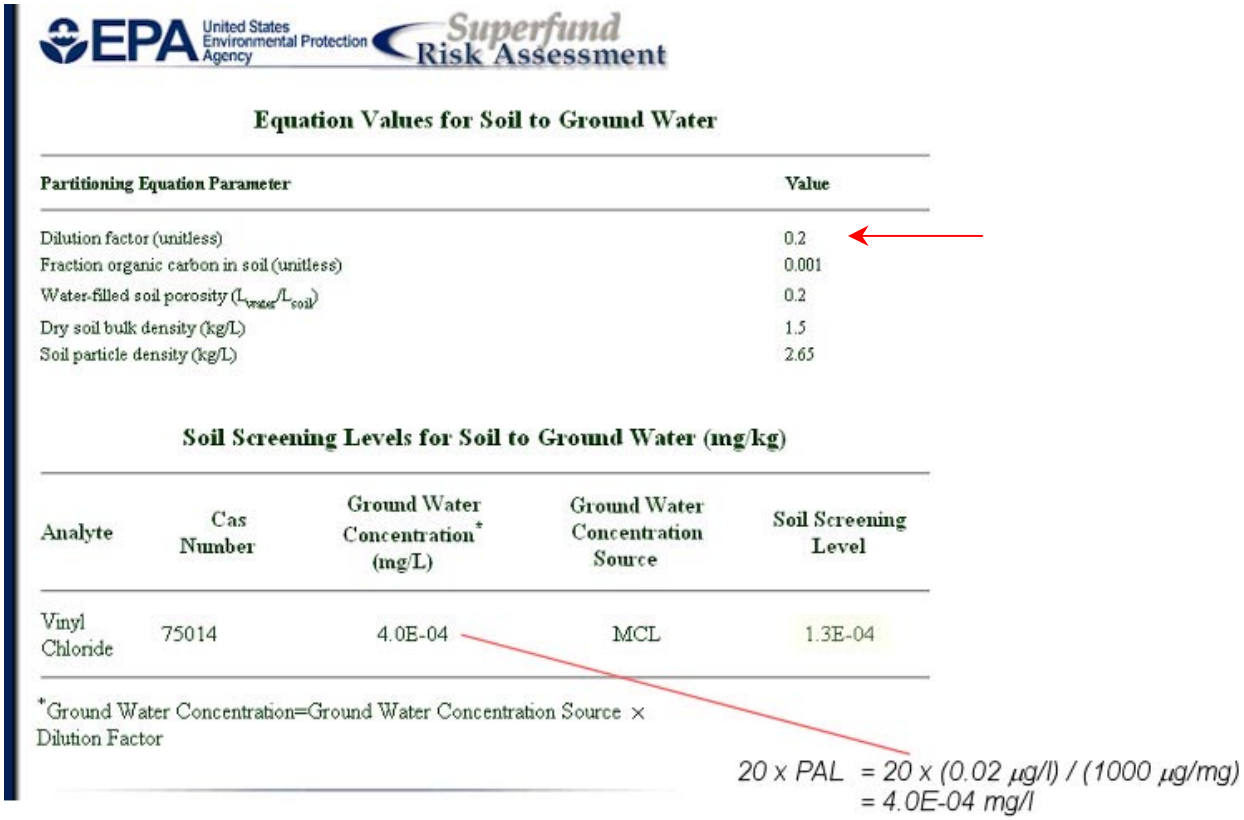
3. For Vinyl Chloride[6] (ES ≠ MCL) *



EPA United States Environmental Protection Agency — Superfund Risk Assessment

Equation Values for Soil to Ground Water

Partitioning Equation Parameter	Value
Dilution factor (unitless)	0.2
Fraction organic carbon in soil (unitless)	0.001
Water-filled soil porosity (L_{water}/L_{soil})	0.2
Dry soil bulk density (kg/L)	1.5
Soil particle density (kg/L)	2.65

Soil Screening Levels for Soil to Ground Water (mg/kg)

Analyte	Cas Number	Ground Water Concentration* (mg/L)	Ground Water Concentration Source	Soil Screening Level
Vinyl Chloride	75014	4.0E-04	MCL	1.3E-04

*Ground Water Concentration=Ground Water Concentration Source × Dilution Factor

20 x PAL = 20 x (0.02 µg/l) / (1000 µg/mg)
= 4.0E-04 mg/l

[6] *For vinyl chloride, the federal MCL (2 ug/l) is 10 times higher than NR 140 ES (0.2 ug/l), so the dilution attenuation factor used in the web page is less than 1. To verify that the RCL is PAL-based, check that the value under the "Ground Water Concentration" is 20 x PAL or less.*

D. Groundwater-Pathway RCL (Another method to estimate PAL-based groundwater [7] RCL)

Equation Values for Soil to Ground Water

Partitioning Equation Parameter	Value
Dilution factor (unitless)	1
Fraction organic carbon in soil (unitless)	0.001
Water-filled soil porosity (L_{water}/L_{soil})	0.2
Dry soil bulk density (kg/L)	1.5
Soil particle density (kg/L)	2.65

Use DF = 1 to get actual HBL or MCL/G used in the web calculation

Soil Screening Levels for Soil to Ground Water (mg/kg)

Analyte	Cas Number	Ground Water Concentration* (mg/L)	Ground Water Concentration Source	Soil Screening Level	x 20 x PAL / HBL (or MCL/G)
Dichloroethane, 1,1-	75343	3.7E+00	HBL	7.3E-01	x 20 x 0.085 / 3.7 = 0.34 mg/kg
Trichloroethane, 1,1,2-	79005	3.0E-03	MCLG	5.7E-04	x 20 x 0.0005 / 0.003 = 0.002 mg/kg

*Ground Water Concentration=Ground Water Concentration Source × Dilution Factor

Factor to multiply web result when DF=1 to get RCL

PAL-based RCL

[7] *The EPA web site uses, in their order of priority, non-zero MCLG first, then MCL, then HBL. The federal MCL (except for vinyl chloride's) is invariably the same as NR 140 ES. If either an HBL or MCLG is used as groundwater reference in an SSL calculation, the dilution attenuation factors in Figure 4 (i.e., 2 for carcinogen, and 4 for non-carcinogen) may not be appropriate. If this is the case, assume a dilution factor of 1, then multiply the resulting Soil Screening Level by 20, then multiply by the ratio between the PAL and HBL (or MCLG) - as shown above - making sure that the units are the same for both PAL and HBL. The results would be PAL-based RCLs. Note that the simple partitioning equation should not be used when the product 20 x PAL is larger than the effective solubility of a compound.*